Evaluation of Neutrinos Mass Based on ENU Model

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Abstract. Based on principles of the Expansive Nondecelerative Universe model that enables to quantify and localize the gravitational energy density, and stemming from the "see-saw" mechanism, the mass of electron, muon and tau neutrinos are determined in an independent way.

Introduction

For a long time, the neutrinos rest mass had been supposed to be of zero value [1]. The opinion has gradually changed, the experimentally observed defficiency of solar neutrinos acting as a driving force of the change. Mutual oscillations of muon ν_μ, tau ν_τ and electron ν_e neutrinos was proposed as a key mode of the defficiency interpretation which, in turn, required a nonzero rest mass of the neutrinos. In our previous paper [2] we have rationalized this defficiency in a different way. There are several approaches to neutrinos masses evaluation. Calculations related to some experiments, e.g. tritium decay have led to an upper limit of the electron neutrino mass. Based on the symmetry between bosons and fermions, and on the relation between the mass of neutrinos and corresponding fermions, we have performed calculation of the mass of all three neutrinos and obtained [3,4] values similar to those generally accepted. In the latest issue of Particle Group Data [5], the following upper limit of the neutrinos mass are listed: $E(\nu_\mu) \leq 0.19$ MeV, $E(\nu_\tau) \leq 18.2$ MeV, and $E(\nu_e) \leq 3$ eV. In this contribution, based on the Expansive Nondecelerative Universe (ENU) model and on the "see-saw" mechanism [6] originally developed by Gell-Mann and his coworkers, the mass of all neutrinos is tentatively determined.

Results and discussion

One of the corner stones of the ENU model states that the mass of all "elementary" particles is generated by gravitational energy of the Planck particle (planckton) possessing the energy

$$E_{Pc} = m_{Pc}.c^2 = 1.2211 \times 10^{19} GeV \tag{1}$$

For the rest energy E of any particle it thus holds [7]

$$E = \int \varepsilon_{g(Pc)} dV_C \cong \frac{m_{Pc}.c^2.\lambda_C}{a_{(T)}} \tag{2}$$

in which λ_C is the Compton wavelength, $\varepsilon_{g(Pc)}$is the planckton gravitational field density, $a_{(T)}$represents the gauge factor related to the specific time when

$$k.T \cong m.c^2 \tag{3}$$

In fact, equation (2) expresses the gravitational energy of planckton in the Compton volume of a given particle.

Neutrinos do not take part in strong and electromagnetic interactions and their gravitational influence can be neglected as well. The only interaction related to neutrinos is weak interaction mediated by vector bosons Z and W. Gravitational influence of the bosons on their surroundings starts just when their Compton wavelength becomes identical to their effective gravitational range [7], i.e. when

$$a_{Z,W} = \frac{\hbar^2}{G.m_{Z,W}^3} \tag{4}$$

where $m_{Z,W}$is the mass of corresponding bosons. To determine a specific value of a neutrino mass, the value of λ_C must be substituted by another distance closely related to the neutrino. As such a quantity, the effective cross section σ of weak interactions has been selected, the value of which reaches

$$\sqrt{\sigma} \cong 8.36 \times 10^{-24} m \tag{5}$$

Relations (2), (4) and (5) lead directly to the electron neutrino mass (energy)

$$m\left(\nu_e\right).c^2 = \frac{m_{Pc}.c^2.\sigma^{1/2}}{a_{Z,W}} \cong 2.2\times 10^{-12} eV \tag{6}$$

It was postulated by the authors of "see-saw" mechanism that relation of the masses of the neutrinos and corresponding particles (electron e, muon μ and tau-lepton τ) can be formulated as follows

$$m\left(\nu_e\right):m\left(\nu_\mu\right):m\left(\nu_\tau\right) = m^2\left(e\right):m^2\left(\mu\right):m^2\left(\tau\right) \tag{7}$$

For the electron, muon and tau-lepton their mass values have been published in [5] and are as follows

$$m\left(e\right) = 0.511003 MeV \tag{8}$$

$$m\left(\mu\right) = 105.658 MeV \tag{9}$$

$$m\left(\tau\right) = 1.777 GeV \tag{10}$$

Applying (6) to (10), in addition to the electron neutrino mass, the following masses are obtained for ν_μ and ν_τ

$$m\left(\nu_\mu\right) \cong 9.4\times 10^{-8} eV \tag{11}$$

$$m\left(\nu_\tau\right) \cong 2.7\times 10^{-5} eV \tag{12}$$

The results are in good agreement with those provided by GUTs within the SU(5) approach (for the electron neutrino it gives $10^{-13} - 10^{-9}$ eV [8]) and they do not exceed the upper currently accepted limiting values [5].

References

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